CHAPTER 2

MAGNETIC TAPE

LEARNING OBJECTIVES

After completing this chapter, you'll be able to do the following:

1. Describe the physical properties of magnetic tape in terms of:

   a. The Three Basic Materials Used To Make Magnetic Tape.

2. The function of the magnetic tape's *base material, oxide coating,* and *binder glue*.

3. Describe the two types of magnetic recording tape.

4. Describe the following types of tape errors and their effects on magnetic tape recording: *signal dropout, noise, skew,* and *level*.

5. Describe the following causes of magnetic tape failure: *normal wear, accidental damage, environmental damage,* and *winding errors*.

6. Describe the purpose and makeup of tape reels and tape cartridges.

7. Describe the two methods for erasing magnetic tape, the characteristics of automatic and manual tape degaussers, and the procedures for degaussing magnetic tape.

8. Describe the proper procedures for handling, storing, and packaging magnetic tape, tape reels, and tape cartridges.

PHYSICAL PROPERTIES OF MAGNETIC TAPE

The three basic materials used to make magnetic tape are (1) the base material, (2) the coating of magnetic oxide particles, and (3) the glue to bind the oxide particles onto the base material. See figure 2-1.

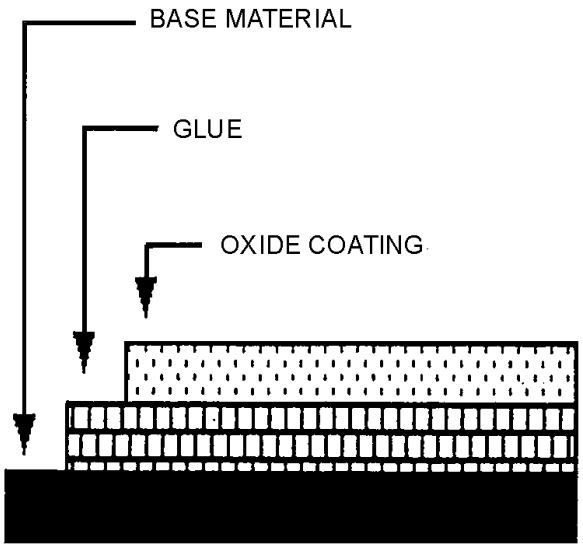

Figure 2-1.—Magnetic tape construction.

BASE MATERIAL

The base material for magnetic tape is made of either plastic or metal. Plastic tape is used more than metal tape because it's very flexible, it resists mildew and fungus, and it's very stable at high temperatures and humidity.

OXIDE COATING

Oxide particles that can be magnetized are coated onto the base material. The most common magnetic particles used are either gamma ferric oxide or chromium dioxide. It's very important that these magnetic particles are uniform in size. If they're not, the tape's surface will be abrasive and will reduce the life of the recorder's magnetic heads.

An ideal magnetic particle is needle-shaped. It's actual size depends on the frequency of the signal to be recorded. Generally, long particles are used to record long wavelength signals (low-frequency signals), and short particles are used to record short wavelength signals (high-frequency signals).

GLUE

The glue used to bond the oxide particles to the base material is usually an organic resin. It must be strong enough to hold the oxide particles to the base material, yet be flexible enough not to peel or crack.

TYPES OF MAGNETIC RECORDING TAPE

There are two basic types of magnetic recording tape in common use: *analog* and *digital*. Analog magnetic tape is used to record, store, and reproduce audio and instrumentation type signals. These signals are usually in a frequency band from very-low frequency (VLF) to 2.5 MHz. Digital magnetic tape is used to record, store, and reproduce computer programs and data. It's base material thickness is about 50 percent thicker than analog magnetic tape. This allows the digital tape to withstand the more strenuous starts and stops associated with digital magnetic recorder search, read, and write functions.

Digital magnetic tape is also held to much stricter quality control standards. It's important not to have any blemishes or coating flaws on the tape's surface. Because, if you lost one digital data bit, your computer program or data would be bad. In contrast, losing one microsecond of an analog signal is not nearly as critical.

Q-1. Magnetic tape is made of what three basic materials?

Q-2. Why is plastic magnetic tape used more than metal tape?

Q-3. Which of the two types of magnetic tape is used to record audio and instrumentation type signals in the VLF to 2.5MHz frequency range?

Q-4. What type of magnetic tape is used to record computer programs and data, and what are the additional thickness and quality standards for this type of tape?

TAPE ERRORS AND THEIR EFFECTS

Four types of tape errors that will degrade the performance of a magnetic recording system are signal dropout, noise, skew, and level (signal amplitude changes).

DROPOUT ERRORS

Signal dropout is the most common and the most serious type of tape error. It's a temporary, sharp drop (50% or more) in signal strength caused by either contaminates on the magnetic tape or by missing oxide coating on part of the tape.

During recording and playback, the oxide particles on the tape can flake off and stick to the recorder's guides, rollers, and heads. After collecting for awhile, the oxide deposits (now oxide lumps) break loose and stick to the magnetic tape. As the tape with the lumps passes over the head, the lumps get between the tape and the head and lift the tape away from the head. This causes the signal dropouts. Although oxide lumps cause most signal dropouts, remember that any contaminate (such as dust, lint or oil) that gets between the tape and the head can cause signal dropouts.

NOISE ERRORS

Noise errors are unwanted signals that appear when no signal should appear. They're usually caused by a cut or a scratch on the magnetic tape. It's the lack of oxide particles at the cut or the scratch that causes the noise error.

SKEW ERRORS

Skew errors only occur on multi-track magnetic tape recorders. The term skew describes the time differences that occur between individual tracks of a single magnetic head when the multi-track tape isn't properly aligned with the magnetic head.

There are two types of skew errors: *fixed* and *dynamic*. Fixed skew happens when properly aligned magnetic tape passes an improperly aligned magnetic head. Dynamic skew happens when misaligned tape passes a properly aligned head. This type of skew is usually caused by one or more of the following:

- A misaligned or worn-out tape transport system.
- A stretched or warped magnetic tape.

- A magnetic tape that is improperly wound on a reel.

LEVEL ERRORS

Magnetic tape is manufactured to have a specified output signal level (plus or minus some degree of error). Level errors happen when the actual output signal level either drops or rises to a level outside the expected range. For example, if a magnetic tape is rated for 10 volts (+/–10%), any output signal level below 9 volts or above 11 volts is a level error. Level errors are caused by an uneven oxide coating on the magnetic tape. This can come from either the original manufacturing process or from normal wear and tear.

Some causes of level errors are permanent and cannot be removed by any means. For example, a crease in the tape, a hole in the oxide, or a damaged edge. Other causes of level errors are removable and may be cleaned off the tape. For example, oxide flakes or clumps, metallic particles, or dirt are removable.

Q-5. What are four types of tape errors that can degrade a magnetic recording system's performance?

Q-6. What are signal dropouts, and what are two tape defects that can cause signal dropouts?

Q-7. What is the most common and most serious type of signal dropout?

Q-8. You see a build-up of dust and lint on the take-up reel of a tape recorder. This can cause which of the four types of tape errors?

Q-9. What type of tape error causes noise to appear on the tape when no signal should appear? What causes this type of tape error?

Q-10. The multi-track tape recorder in your computer system has a fixed skew error. What does this mean and what is the probable cause?

Q-11. Some tapes you are using may have level errors. What does this mean and what is the cause?

CAUSES OF MAGNETIC TAPE FAILURE

Tape failure happens when a magnetic tape's performance degrades to a point where it's no longer usable. The *exact* point where failure occurs will vary, depending on the type of tape and how it is used.

There are four main causes for tape failure:

1. Normal wear (natural causes)
2. Accidental damage
3. Environmental damage
4. Winding errors

NORMAL WEAR

Normal wear occurs because the tape must come in contact with fixed surfaces, such as a recorder's magnetic heads, rollers, and guides. Over time, this repeated contact with the fixed surfaces causes excessive dropout errors and makes the tape unusable.

ACCIDENTAL DAMAGE

Accidental tape damage that causes tape failure is any damage that wouldn't normally occur under ideal operating and handling conditions. It can be caused by either a human operator or the tape recorder itself. Accidental tape damage caused by human operators can range from accidentally dropping a reel of magnetic tape to improperly threading a magnetic tape recorder. Accidental tape damage caused by recording equipment can occur if the recorder is poorly designed or if the tape transport mechanism is adjusted improperly.

ENVIRONMENTAL DAMAGE

The negative effect of environmental extremes on tape can also cause tape failure. Magnetic tape is very flexible and can be used in a wide range of environmental conditions. It's designed for use in a temperature range of about 2 to 130 degrees Fahrenheit (−20 to 55 degrees Celsius), and in a relative humidity range of about 10 to 95%. Of course, these numbers are the *extreme*. Ideally, magnetic tape should be used and stored at a temperature of about 60 to 80º F (room temperature), and in a relative humidity of about 40 to 60%.

Large changes from the ideal relative humidity cause tape to expand or contract and thus affect the uniformity of a tape's oxide coating. High relative humidity causes the tape to stretch and increases the tape's friction. The increased friction causes increased head wear, head clog by oxide particles, and head-to-tape sticking. Low relative humidity encourages oxide shedding and increases static build-up on tape surfaces, causing the tape to collect airborne contaminants.

The effects of exceeding the ideal temperature and humidity ranges described above can cause the following environmental damage to magnetic tape: *tape deformation, oxide shedding, head-to-tape sticking, layer-to-layer sticking, dirt build-up, and excessive tape and head wear.*

Tape Deformation

Magnetic tapes are wound onto tape reels with tension applied. This tension causes great layer-to-layer pressure within the reel pack. Changes in temperature and humidity can cause the backing material to expand or contract, creating even more pressure. All of this pressure causes the tape to become deformed or warped.

Oxide Shedding

At temperatures above 130º F, a tape's oxide coating tends to become soft. At temperatures below 2º F, the oxide coating tends to be brittle. In both cases, the oxide coating will shed, flake off, or otherwise become separated from the base material. These free pieces of oxide will then stick to parts of the tape transport, to the magnetic heads, or back onto the tape and cause dropout or level errors.

Head-to-Tape Sticking

At higher temperatures, the tape binder glue can soften to the point where it will stick to the recorder's magnetic head. This head-to-tape sticking causes jerky tape motion.

Layer-to-Layer Adhesion

When reels of magnetic tape are stored at higher temperatures, the tape's binder glue may melt and cause the layers of tape to stick to one another. In very severe cases, layer-to-layer adhesion can separate the oxide coating from the base material and completely destroy a tape.

Dirt Build-up

Dirt build-up happens when the relative humidity level is less than 10%. The low humidity causes static electricity that attracts dirt and dust which builds up on the magnetic tape and other parts of the magnetic tape recorder.

Excessive Tape and Head Wear

When the relative humidity is more than 95%, the high humidity causes increased friction as the tape passes over the heads. This, in turn, causes excessive tape and head wear.

Q-12. What is tape failure?

Q-13. What are four main causes of tape failure?

Q-14. How does normal wear cause tape failure?

Q-15. Accidental damage to magnetic tape is normally caused by the tape recorder itself or by human operators of the recorder. What are three frequent causes of such accidental damage?

Q-16. Environmental damage to magnetic tape can occur when the tape is stored in an area that exceeds what ideal temperature and humidity ranges?

Q-17. What six types of environmental damage can occur to tapes in storage when the ideal temperature and humidity ranges are exceeded?

Q-18. After using a tape that was stored in an area where temperatures exceeded 130º F you notice pieces of oxide sticking to the recorder's tape-transport mechanism, to its magnetic heads, and onto the tape. What is the probable cause of these symptoms?

Q-19. Your activity stores its magnetic tape in an area where the temperature is 100º F. What two types of environmental damage could occur that would make these tapes unusable?

Q-20. When the relative humidity is below 10%, what happens to magnetic tape and parts of a tape recorder that could cause environmental damage?

Q-21. How does relative humidity over 95% cause excessive tape and head wear?

WINDING ERRORS

Winding errors are another cause of tape failure. They happen when improper winding practices create an excessive or uneven force as the tape is being wound onto a tape reel. The form taken by the tape after it is wound onto the reel is called the *tape pack*. Winding errors can cause a deformed tape pack that will prevent good head-to-tape contact.

In most cases, a deformed tape pack can be fixed simply by rewinding it onto another reel at the proper tension and at the right temperature and humidity. The four most common types of tape pack deformation are:

1. Cinching
2. Pack-slip
3. Spoking

4. Windowing

Cinching

Cinching happens when a tape reel is stopped too quickly. The sudden stop causes the outer layers of magnetic tape to continue to spin after the inner layers have stopped. This causes any loosely wound tape within the pack to unwind and pile up. Figure 2-2 shows an example of a cinched tape pack (note the complete foldover of one tape strand).

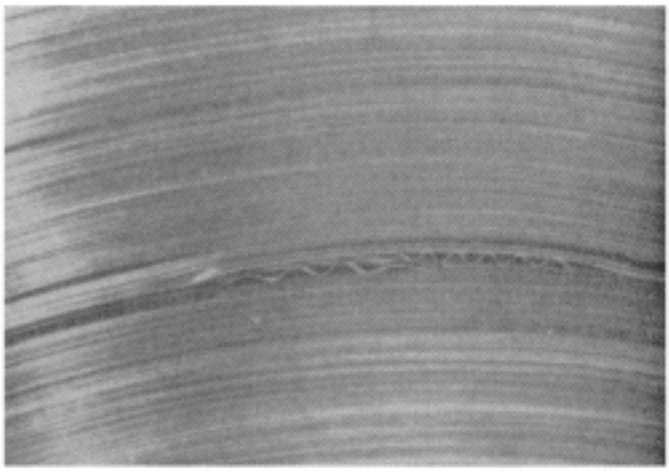

Figure 2-2.—Example of cinched tape pack.

Pack Slip

Pack slip happens when the tape is loosely wound on the reel and is exposed to excessive vibration or too much heat. This causes the tape to shift (side-to-side), causing *steps* in the tape pack. When a tape reel with pack slip is used, the magnetic tape will unwind unevenly and rub against the sides of the tape reel or the recorder's tape guides. This can damage the magnetic tape and cause oxide shedding. Figure 2-3 shows an example of pack slip.

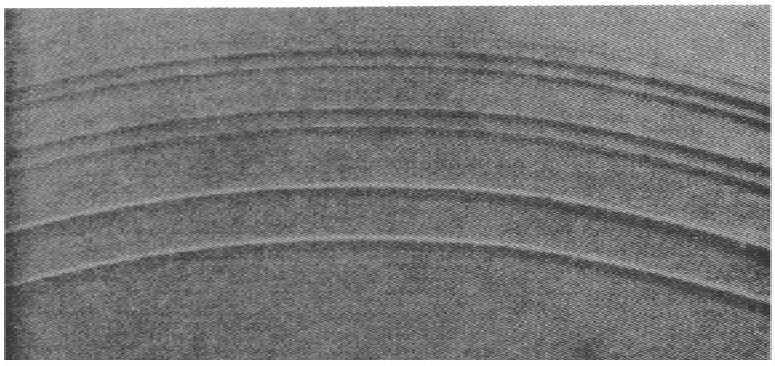

Figure 2-3.—Example of pack slip.

Spoking

Spoking happens when magnetic tape is wound onto the tape reel with the tension increasing toward the end of the winding. The higher tension on the outside of the tape pack causes the inner pack to buckle and deform. Spoking is also caused by the uneven pressures created when a tape is wound on a reel that has a distorted hub, or when the tape is wound over a small particle that is deposited on the hub. Figure 2-4 shows a spoked tape pack.

Figure 2-4.—Example of spoked tape pack.

Windowing

Windows are voids or see-through air gaps in the tape winding. They happen when magnetic tape is loosely wound onto a tape reel, and especially when the loosely wound reel is later exposed to extreme heat or humidity. Figure 2-5 shows a windowed tape pack.

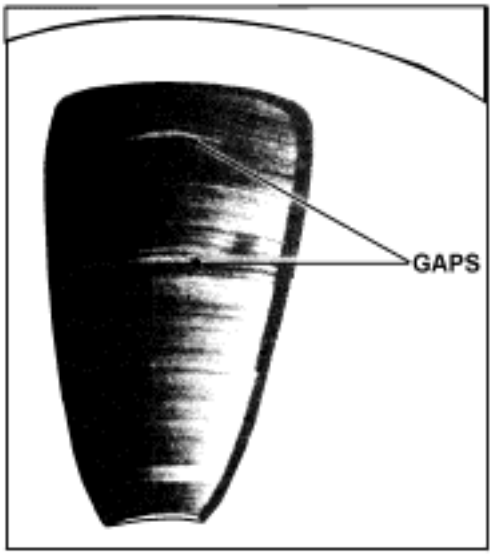

Figure 2-5.—Example of windowed tape pack.

Q-22. Tape winding errors can cause a deformed tape pack. What are four common types of tape pack deformation?

Q-23. After rewinding a tape onto its supply reel, you examine the tape pack and notice pile-ups of tape resembling the example in figure 2-2. What causes this condition?

Q-24. You notice steps in the tape pack such as those in figure 2-3. What causes this and how does it damage the magnetic tape?

Q-25. A tape pack is buckled and deformed as shown in figure 2-4. What are three possible causes for this condition?

Q-26. A tape pack has gaps in the tape winding as shown in figure 2-5. What causes this condition?

TAPE REELS AND TAPE CARTRIDGES

There are two types of magnetic tape carriers: tape *reels* and *tape* cartridges. Both types can be used for either analog or digital recording. Tape cartridges are normally used only for digital recording.

TAPE REELS

Tape reels are used on magnetic recorders that use a manually loaded tape supply reel and a separate take-up reel. A reel's purpose is to protect the magnetic tape from damage and contamination. It can be made of plastic, metal, or glass. A reel has two parts, the hub and the flanges.

A tape reel is designed to hold magnetic tape on its hub without letting the magnetic tape touch the sides of the flanges. Contrary to popular belief, the flanges are not designed to *guide* the magnetic tape onto the tape reel.

TAPE CARTRIDGES

Tape cartridges hold a spool of magnetic tape in the same way as tape reels, except that the inside of the cartridge contains both the supply reel and the take-up reel. Unlike tape reels which must be manually loaded into a recorder, when you insert a tape cartridge into a recorder, it's automatically loaded and ready to use. Figure 2-6 shows two typical tape cartridges.

Figure 2-6.—Typical tape cartridges.

Q-27. When winding a tape onto a plastic or metal reel, should the tape ever touch the reel's flanges?

TAPE ERASING AND DEGAUSSING

One advantage of magnetic tape is that you can erase what you've previously recorded, and record on the same tape again and again. The erasing is done by demagnetizing the magnetic tape. You demagnetize a magnetic tape by exposing it to a gradually decreasing ac (alternating current) magnetic field. There are two ways to do this: (1) with an *erase head* that's mounted on the magnetic recorder, or (2) with a separate *tape degausser*.

ERASE HEADS

A magnetic recorder's erase head erases magnetic tape by saturating it with an ac signal that's higher in frequency than the frequency range of the recorder itself. This method of erasing a tape works well in some cases, but it's not the best way because:

- It's slow; the tape must be run through the recorder to be erased.

- If the erase head is not completely demagnetized, it may not do a complete erasure.
- Some recorders do not have erase heads installed.

MAGNETIC TAPE DEGAUSSERS

By far, the best way to erase a magnetic tape is to use a separate magnetic tape degausser. There are two types of degaussers: *automatic* and *manual*.

Automatic Tape Degausser

Automatic degaussers erase magnetic tape by automatically moving the whole tape reel or cartridge slowly and steadily in and out of an intense ac magnetic field. This type of degausser erases a tape very well. Some automatic degaussers are made specifically for tape reels, and some are made for both tape reels and tape cartridges. Figure 2-7 shows a typical automatic degausser.

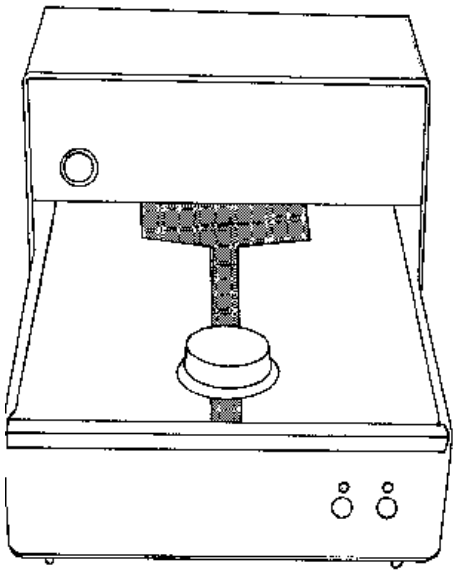

Figure 2-7.—Automatic tape degausser.

Manual Tape Degausser

Both manual and automatic tape degaussers use the same electronic principles for erasing magnetic tape. However, the manual version is much more portable. It's small, hand-held, and much less expensive. Figure 2-8 shows a typical manual degausser.

Figure 2-8.—Manual tape degausser.

To erase tapes with a manual degausser:

1. Place the tape reel or cartridge to be erased on a flat surface.
2. Hold the degausser very close to the magnetic tape and turn it on.
3. Slowly rotate the degausser in circles around the tape reel or cartridge for a few seconds.
4. Then slowly move it away until you're about 12 to 14 inches away from the tape reel or tape cartridge.
5. Turn off the degausser.

Q-28. What are two disadvantages of using a recorder's erase head to erase data recorded on a magnetic tape?

Q-29. What method for erasing magnetic tape is much more effective and reliable than using a recorder's erase head?

HANDLING, STORING, AND PACKAGING MAGNETIC TAPE

Today's magnetic tape coatings can store recorded signals for years. The data recorded is a permanent record that won't fade or weaken with age. And, it'll remain unchanged until it's altered by another magnetic field or until the tape coating deteriorates.

When magnetic tape recordings are ruined, the cause is usually poor handling, improper storage, or shipping damage. If you want your tape recordings to last a long time, you need to know how to properly handle, store, and ship magnetic tape.

HANDLING MAGNETIC TAPE

A magnetic tape reel or cartridge should always be in one of two places, either mounted on a tape recorder or in its storage container. When you handle magnetic tape, follow these rules:

- DO use extreme care when handling magnetic tape. Careless handling can damage magnetic tape, tape reels, and tape cartridges. Always hold a tape reel by the hub, NEVER by the flanges, and NEVER handle or touch the working tape surface.
- DO NOT let the magnetic tape trail on the floor. Even though the end of the tape may not have data stored on it, it can pick up dirt and dust that ends up on the recorder.
- DO clean your hands before handling magnetic tape. You can contaminate magnetic tape with dirt and oils from dirty hands.
- DO mount tape reels and cartridges properly. Improperly seated tape reels can cause unnecessary wear and tear on the magnetic tape.
- DO replace any warped take-up reels, as they can damage magnetic tape.
- DO keep the magnetic recorder and its take-up reel clean. Magnetic tape can pick up dirt and dust from the recorder itself.
- DO NOT use the top of a magnetic recorder as a work area. This can expose the magnetic tape to dirt, excessive heat, and stray magnetic fields.
- DO NOT allow eating, drinking, or smoking in areas where magnetic tape or devices are exposed.

STORING MAGNETIC TAPE

Most magnetic tape reels and cartridges spend a lot of time in storage. It's very important that you protect the stored tape from physical damage and the damaging effects of contamination and temperature and humidity extremes. If you don't, damage to the tape pack such as oxide shedding, layer-to-layer sticking, and tape deformation can happen. To protect magnetic tape from damage during storage, follow these rules:

- DO make sure that magnetic tape is wound properly on the reel hub and at the proper tension.
- DO always store tape reels vertically. DO NOT lay them on their side.
- DO maintain a proper environment. Keep the storage area clean, and at a 60 to 80F degree temperature and a 40 to 60% relative humidity.
- DO NOT store magnetic tapes near any equipment that generates stray magnetic fields.
- DO handle <u>all</u> tape reels and cartridges as gently as possible.
- DO NOT eat, drink, or smoke in a magnetic tape storage area.

PACKAGING MAGNETIC TAPE FOR SHIPPING

There may be times when you are asked to package magnetic tape reels or tape cartridges for shipment. If you want the tape to arrive in good condition, you must pack it properly to protect it from damage. The packaging you use must protect the tape reels or cartridges from impact, vibration, and temperature and humidity changes. Here are some simple rules to follow:

- DO always package tape reels so that they're supported by their hub. This prevents any pressure on the reel's flanges that might flex the flanges against the tape pack. Figure 2-9 shows a shipping box that supports the tape reel by the hub.

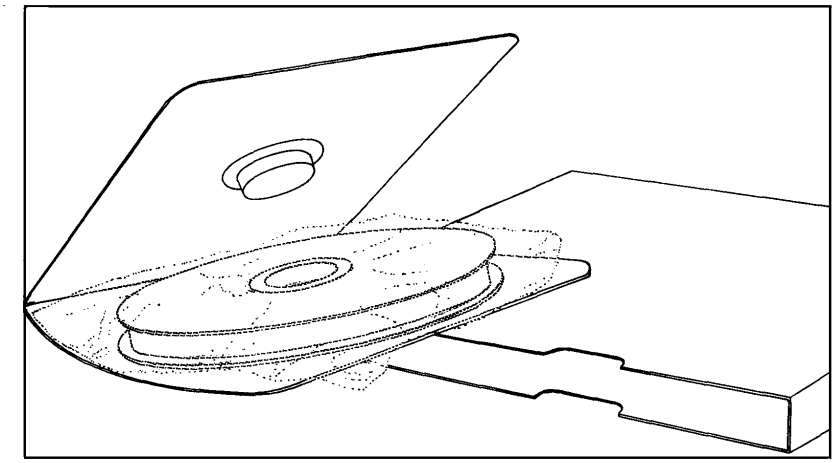

Figure 2-9.—Reel box that supports reel by the hub.

- DO always use reel bands where available. Reel bands are for placement around the outside edges of the reel flanges to help prevent the flanges from flexing and damaging the tape.

- DO always ship magnetic reels in a container designed so its normal positioning is with the reels in a vertical position. This will prevent the tape pack from shifting and damaging the edges of the magnetic tape.

- DO always package tape cartridges in their shipping cases. Tape cartridges are more durable than tape reels, but they still need to be protected during shipment.

Q-30. When magnetic tapes are ruined, what three factors are normally the cause?

Q-31. What is the correct way to hold a magnetic tape reel?

Q-32. The take-up reel on your recorder is warped. What should you do to/with the reel?

Q-33. If magnetic tape is stored in areas with temperature and humidity extremes, what are three types of tape damage that may occur?

Q-34. List four rules you should follow when storing magnetic tape to protect it from damage.

Q-35. When packaging tape reels or cartridges for shipping, what are four rules you should follow to protect the tape reels from impact and vibration?

SUMMARY

Now that you've finished chapter 2, you should be able to (1) describe the physical properties of magnetic tape, (2) recognize the four most common magnetic tape errors, (3) recognize the four causes of tape failure, (4) describe the two methods for erasing magnetic tape, and (5) use the proper procedures for handling, storing, and packaging magnetic tape, tape reels, and tape cartridges. The following is a summary of the important points in this chapter.

The three **BASIC MATERIALS** used to make magnetic tape are the (1) base material, (2) the oxide particles, and (3) the binder glue.

ANALOG and **DIGITAL** are the two basic types of magnetic tape in common use.

BLEMISHES OR **COATING FLAWS ON DIGITAL TAPE** can easily ruin the data or the computer program stored on the tape.

SIGNAL DROPOUT, NOISE, SKEW, AND **LEVEL** are four types of tape errors. Dropout errors are the most common.

OXIDE LUMPS accumulated on the tape cause most dropout errors. Other causes are dust or lint on the tape, or missing oxide coating on part of the tape.

MAGNETIC TAPE FAILURE has four main causes: (1) normal wear, (2) accidental damage, (3) environmental damage, and (4) winding errors.

IDEAL TEMPERATURE AND HUMIDITY RANGES for using and storing magnetic tape are 60 to 80º F and 40 to 60% relative humidity.

ENVIRONMENTAL TAPE DAMAGE caused by excessive temperature or humidity includes the following: (1) tape deformation, (2) oxide shedding, (3) head-to-tape sticking, (4) layer-to-layer sticking, (5) dirt buildup, and (6) excessive tape and head wear.

WINDING ERRORS can cause tape pack deformation. The four most common types are: (1) cinching, (2) pack slip, (3) spoking, and (4) windowing.

The **TWO PARTS OF A TAPE REEL** are the hub and the flanges. The tape should be wound on the hub. No part of the tape should be touching the flange sides.

ERASE HEADS AND **TAPE DEGAUSSERS** are two methods for erasing tape. Degaussers are the fastest and the most reliable.

Rules for **HANDLING MAGNETIC TAPE** are (1) always hold the reel by the hub, not the flanges, (2) never touch the working tape surface, (3) replace warped or damaged reels, and (4) mount reels and cartridges properly.

Rules for **STORING MAGNETIC TAPE** are (1) wind tape properly on the reel hub, (2) store tapes vertically, (3) keep storage area clean and at proper temperature and humidity levels, and (4) store tapes away from equipment that generates stray magnetic fields.

Rules for **PACKAGING TAPE FOR SHIPPING** are (1) support reels by their hubs, (2) use reel bands, (3) pack reels in containers vertically, and (4) keep tape cartridges in their shipping cases.

ANSWERS TO QUESTIONS Q1. THROUGH Q35.

A-1.

a. Base material.

b. Coating of magnetic oxide particles.

c. Glue that bonds the particles to the base.

A-2. Plastic tape is used more than metal because it's more flexible, resists mildew and fungus, and is very stable at high temperatures and humidity.

A-3. Analog magnetic tape.

A-4. Digital magnetic tape is for computer programs and data. Its base material is about 50% thicker. The tape's surface must not have blemishes or coating flaws because losing even one digital data bit could ruin the recorded computer program or data.

A-5. Signal dropout, noise, skew, and level. Dropout is the most common.

A-6. Dropouts are temporary, sharp drops (50% or more) in signal strength. They're caused by contaminates that lift the tape away from the magnetic head, or when magnetic oxide coating is missing on part of the tape.

A-7. Oxide particles that get onto the magnetic tape.

A-8. Signal dropout errors and level errors. The dust and lint on the reel will eventually get onto the tape where it can get between the tape and the recorder's heads.

A-9. Noise error is usually caused by a cut or a scratch on the magnetic tape.

A-10. Skew means there are time differences between the individual tracks of a multi-track recorder's magnetic head. It happens when the tape isn't properly aligned with the head. Fixed skew happens when the tape passes over an improperly aligned magnetic head.

A-11. The actual output signal level of the tape exceeds the manufacturer's specified range for the output signal level (+ / – 10%). It's caused by an uneven oxide coating on the tape due to worn tape or defective manufacture.

A-12. Tape's performance degrades to a point where it's no longer usable.

A-13. Normal wear, accidental damage, environmental damage, and winding errors.

A-14. Repeated contact with a recorder's fixed surfaces such as magnetic heads, tape rollers, and tape guides.

A-15.

a. Improperly adjusted tape transport mechanism.

b. Dropping a reel of tape.

c. Improperly threading tape.

A-16. Ideally, use and store tape at 60 to 80º F and at 40 to 60% relative humidity.

A-17. Tape deformation, oxide shedding, head-to-tape sticking, layer-to-layer sticking, dirt build-up, and excessive tape and head wear.

A-18. Oxide shedding. At temperatures above 130º F, oxide coating becomes soft and sheds.

A-19. Head-to-tape sticking and layer-to-layer adhesion.

A-20. Dirt build-up caused by static electricity.

A-21. High humidity causes increased friction as the tape passes over the heads.

A-22. Cinching, pack slip, spoking, and windowing.

A-23. The tape is stopped too quickly when winding or rewinding.

A-24. Pack slip. It's caused by loosely wound tape on a reel that is exposed to excessive vibration or heat. The vibration or heat causes the tape to shift, causing steps in the tape pack. The uneven tape will then rub against the reel's sides and the recorder's tape guides.

A-25.

a. Reel has a distorted hub,

b. tape wound over small particle deposited on hub, and

c. tape wound on reel with tension increasing toward end of winding.

A-26. Tape is loosely wound on reel.

A-27. No. The reel is designed to hold the tape on its hub without letting the tape touch the sides of the flanges.

A-28. Using an erase head is slow, and it may not completely erase the tape.

A-29. Using a magnetic tape degausser.

A-30. Poor handling, improper storage, or shipping damage.

A-31. Always hold reel by the hub, never by the flanges. Never touch the working tape surface.

A-32. Always replace a warped reel.

A-33. Oxide shedding, layer-to-layer sticking, and tape deformation.

A-34.

a. Make sure the tape is wound properly on the reel hub,

b. store tapes vertically,

c. keep storage area at right temperature and humidity,

d. store away from equipment that generates stray magnetic fields.

A-35.

a. Package reels so they're supported by their hub,

b. use reel bands,

c. package reels in vertical position,

d. package tape cartridges in their shipping cases.